

Atmospheric pollution in cities of Russia: statistics, causes and characteristics

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Abstract. The article considers the issues of air pollution assessment in Russian industrial regions (2014) and cities (2012). The statistical data is presented both in terms of absolute emissions of pollutants into the atmosphere of Russian cities and relative air pollution calculated for 1 average statistical inhabitant. Classifications of the ecological state of Russian cities on the basis of specific (per inhabitant) air pollution and the air pollution by predominant type source (stationary or non-stationary) are proposed.

1. Introduction

A simple idea that sustainable economic development is only possible through continuous improvement of production technology of the gross domestic product closely linked to the concept of technological paradigm, i.e, aggregate of conjugate productions that have a comparable scientific and technological level and develop synchronously.

Today, in the majority of industrialized countries manufacturing industry of the fifth technological stage reached maturity phase, and an urgent task are practical problems of development and production relating to the sixth technological stage. At the same time all around the world, including Russia, there are still existing and functioning productions, based on the achievements not only of the fifth, but the second and the third and the fourth technological stages. It is mainly the steel industry, heavy machinery, petrochemistry. Typically, the geographical location of such enterprises is localized and there are whole clusters of urban areas, with a common history and similar trends and development issues. Vivid examples of such clusters in Russia may be Ural and Kuzbass.

One of the most problematic features of the people living in these regions is a bad environment [1]. Significant parameters of environmental pollution, mainly – from stationary sources [2, 3], are inherent for the entire districts of Sverdlovsk regions, Chelyabinsk regions, Kemerovo regions. Of course, in recent years much has been done to improve the environmental situation in the industrialized regions of the country. Many industries, especially the sphere of mining and processing and metallurgical production, are equipped with filters and cleaning systems of emissions. In general we can say that in recent years in Russian cities emissions of pollutants into the environment has decreased significantly. However, the problem is not completely solved. Emissions of contaminants into the atmosphere in many industrial cities remain relatively high. And in the cities, where the industrial environment has more favorable situation, today the role of the main pollutant of the atmosphere performs road transport [4, 5].



In this article issues of the industrial regions and cities of Russia ranking in terms of “Absolute values of pollutants emissions” and “Unit (per person per year) emissions of pollutants” are considered.

2. Basic data

In [6] shows chronologically the most actual statistics, characterizing the actual emissions of pollutants into the atmosphere in the most problematic territories (total 34 areas) from the position of ecology in cities and industrial regions of Russia in 2014.

On the basis of the data [6] table 1 is made up. Commenting on the data of Table 1 it should be noted that for the comparative assessment of the environmental situation in the cities of the country, with different area, population and other characteristics, it is necessary to use specific indicators, such as “Specific emissions of pollutants (per pers. per year)” SEP (1):

$$SEP = \text{Specific emissions of pollutants} = \left[\frac{\text{Emission of pollutants} - \text{total}}{\text{Population}} \right], \quad (1)$$

where *Specific emissions of pollutants* – Specific emissions of pollutants, tons/pers./year;

Emissions of pollutants – total – Emissions of pollutants – total, thousands, tons/year;

Population – Population (2014), pers.

Table 1. The ranking of cities of the Russian Federation in terms of actual emissions of pollutants into the atmosphere (2014) [6]

No. of ranking	Cities and industrial areas of Russian Federation	Population (2014), pers.	Emissions of pollutants – total, thousands, tons/year	Specific emissions of pollutants, tons/pers./year
1	Norilsk	176559	1841.3	10.428
2	Reftinskiy industrial area	≈ 66800	315.8	4.727
3	Cherepovets	316758	313.7	0.990
4	Lipetsk	509719	291.1	0.571
5	Usinsk	39831	289.8	7.275
6	Novokuznetsk industrial area	≈ 600000	276.4	0.461
7	Magnitogorsk industrial area	≈ 633700	227.7	0.359
8	Vorkuta	61638	191.1	3.100
9	Omsk	1166092	174.3	0.149
10	Ufa	1096702	148.2	0.135
11	Nizhny Tagil	357280	145.7	0.407
12	Chelyabinsk industrial district	≈ 1250000	140.2	0.112
13	Krasnoyarsk	1035528	129.8	0.125
14	Bratsk	238825	119.3	0.499
15	Novocherkassk	173464	108.7	0.627
16	Astrakhan	530863	104.4	0.196
17	Novosibirsk	1547910	102.6	0.066
18	Mezhdurechenskiy industrial area	≈ 110000	100.8	0.916
19	Kachkanarsky industrial area	40260	77.8	1.932
20	Myskoskiy industrial area	≈ 43000	70.2	1.632
21	Kaltanskiy industrial area	≈ 22000	69.2	3.145
22	Irkutsk	612973	68.0	0.111

No. of ranking	Cities and industrial areas of Russian Federation	Population (2014), pers.	Emissions of pollutants – total, thousands, tons/year	Specific emissions of pollutants, tons/pers./year
23	Novotroitsk	93578	65.5	0.700
24	Serov industrial area	106572	65.3	0.612
25	Verkhneufaley industrial area	33366	64.0	1.918
26	Polysayevskiy industrial area	≈ 29500	63.7	2.159
27	Tula	490508	62.7	0.127
28	Belovsky industrial area	≈ 75000	62.5	0.833
29	Surgut	332313	57.5	0.173
30	Kostomuksha industrial area	29586	56.0	1.892
31	Sterlitamak	277048	53.8	0.194
32	Troitsky industrial district	77176	53.8	0.697
33	Nazarovo	51437	51.2	0.995
34	Stary Oskol industrial area	257128	51.0	0.198

More extensive information about specific (per pers. per year) emissions of air pollutants in the cities of Russia is shown in [7] as in 2012. It should be noted that this document provides information on the actual specific emissions (t/pers./year) in an atmosphere of 180 cities of the Russian Federation.

Figure 1 shows a histogram of the distribution of cities in Russia (2012) in groups depending on the value of specific total emissions of air pollutants per inhabitant per year.

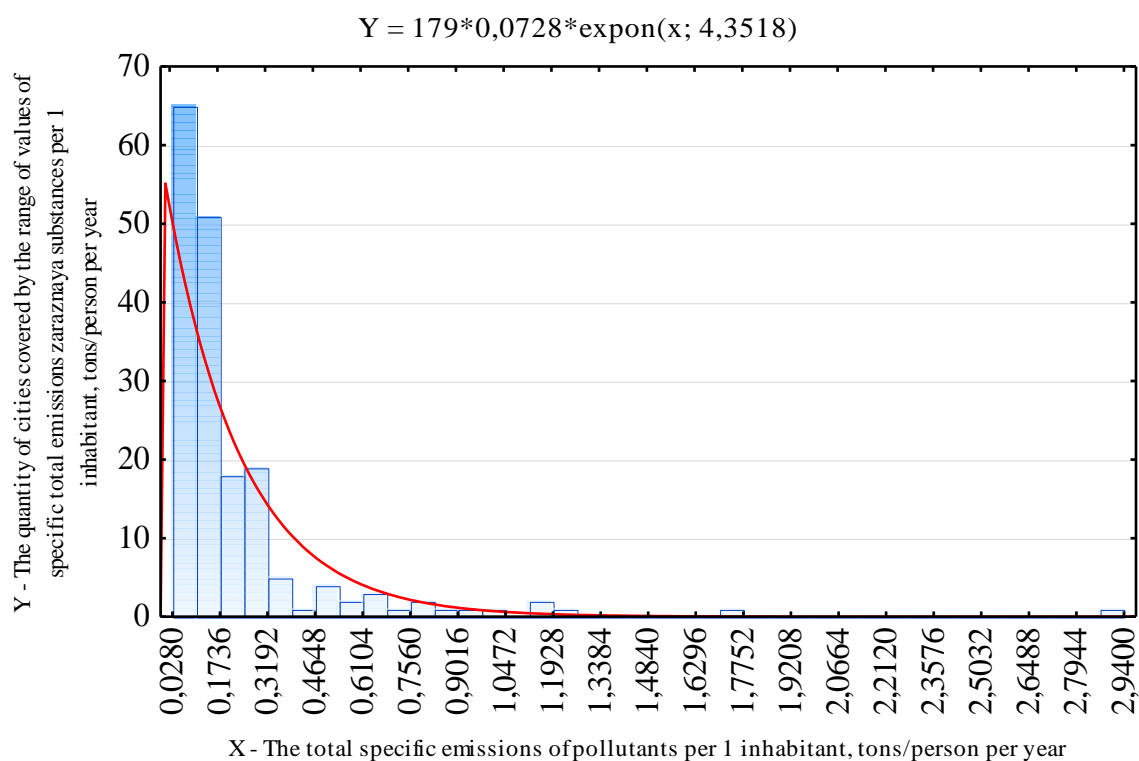


Figure 1. The histogram of distribution of cities in Russia (2012) in groups depending on the value of specific total emissions of air pollutants per inhabitant per year

3. Results and Discussion

Analysis shows that the cities can be classified into groups depending on the value of this parameter (table 2).

Table 2. The frequency characteristic of Russian cities classification (2012) on the basis of “Specific total emissions of air pollutants per inhabitant per year”

Indicator	Groups of cities on the basis of “Specific total emissions of air pollutants per inhabitant per year”, tons/pers./year				
	I	II	III	IV	V
Range of values	0.028–0.100	0.101–0.173	0.174–0.246	0.247–0.319	> 0.319
Quantity of cities in group	65	52	18	18	27

Almost two thirds of the number of examined cities (117 of 180) refer to classification groups I and II, i.e. to relatively safe from the point of city ecology. At the same time the existence of large number of cities, where for 1 person annually 200 kg or more air pollutants are thrown is a demonstrative example of complex environmental situation.

Table 3 shows the rating of Russian cities with the most polluted atmosphere. Analysis of the table 3 data shows that in 2014 in some Russian cities some progress in reducing the emission of pollutants into the atmosphere has been achieved. Thus, positive changes were observed in almost all the cities of the Russian Federation, for which there is relevant statistics, with the exception of Vorkuta. At the same time, emissions statistics in Norilsk is so shocking that the positive developments in 2014 in comparison with 2012 seem to be very insignificant.

Table 3. The ranking of Russia's most polluted cities (2012/2014) in terms of “Specific total emissions of air pollutants per inhabitant per year” (Group V in 2012) [6, 7]

No. of ranking	Russian city of group V in environmental classification	Value of indicator “Specific total emissions of air pollutants per inhabitant per year”, tons/pers./year	
		2012	2014
1	Norilsk	11.054	10.428
2	Vorkuta	2.940	3.100
3	Krasnouralsk	1.707	No data
4	Angarsk	1.198	No data
5	Cherepovets	1.158	0.990
6	Krasnoturinsk	1.156	No data
7	Novodvinsk	1.042	No data
8	Monchegorsk	0.907	No data
9	Rezh	0.864	No data
10	Serov	0.797	0.612
11	Novocherkassk	0.774	0.627
12	Zarinsk	0.735	No data
13	Lipetsk	0.636	0.571
14	Magnitogorsk	0.624	0.359
15	Kstovo	0.614	No data
16	Novokuznetsk	0.584	0.461
17	Bratsk	0.553	0.499
18	Orsk	0.517	No data

No. of ranking	Russian city of group V in environmental classification	Value of indicator “Specific total emissions of air pollutants per inhabitant per year”, tons/pers./year	
		2012	2014
19	Achinsk	0.514	No data
20	Okha	0.510	No data
21	Noyabrsk	0.477	No data
22	Nizhny Tagil	0.415	0.407
23	Anadyr	0.392	No data
24	Gubkin	0.378	No data
25	Stary Oskol	0.363	0.198
26	Artem	0.337	No data
27	Surgut	0.331	0.173

Researcher of urban environment atmosphere is interested in the question of the source of contamination. All sources can be classified into stationary and mobile (vehicles) [8]. Information about sources of pollution in urban areas has been obtained in [7] and presented as a classification in Table 4.

Figure 2 ... 3 shows charts of values of indicator “Proportion in the total volume of pollution emissions into urban atmosphere of the internal combustion engine emissions” in the cities of I and V classification groups (Table 4). Note that cities of I group are cities where practically no industrial enterprises, implementing emissions of pollutants into the atmosphere (cities of resort specialization), or large in terms of population and the level of the city motorization, where the problem of cities' significant pollution by car takes rampant.

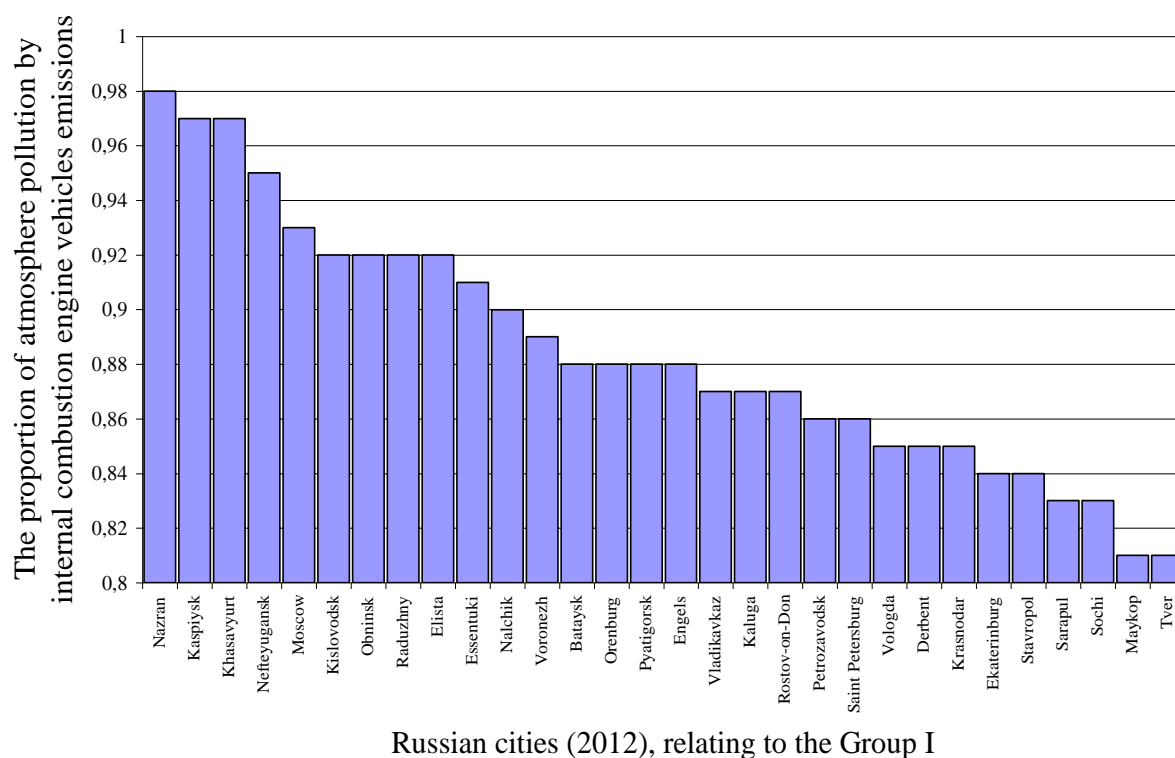


Figure 2. Russian cities (2012), relating to the Group I of classification on the basis of indicator “The proportion of atmosphere pollution by internal combustion engine vehicles emissions”

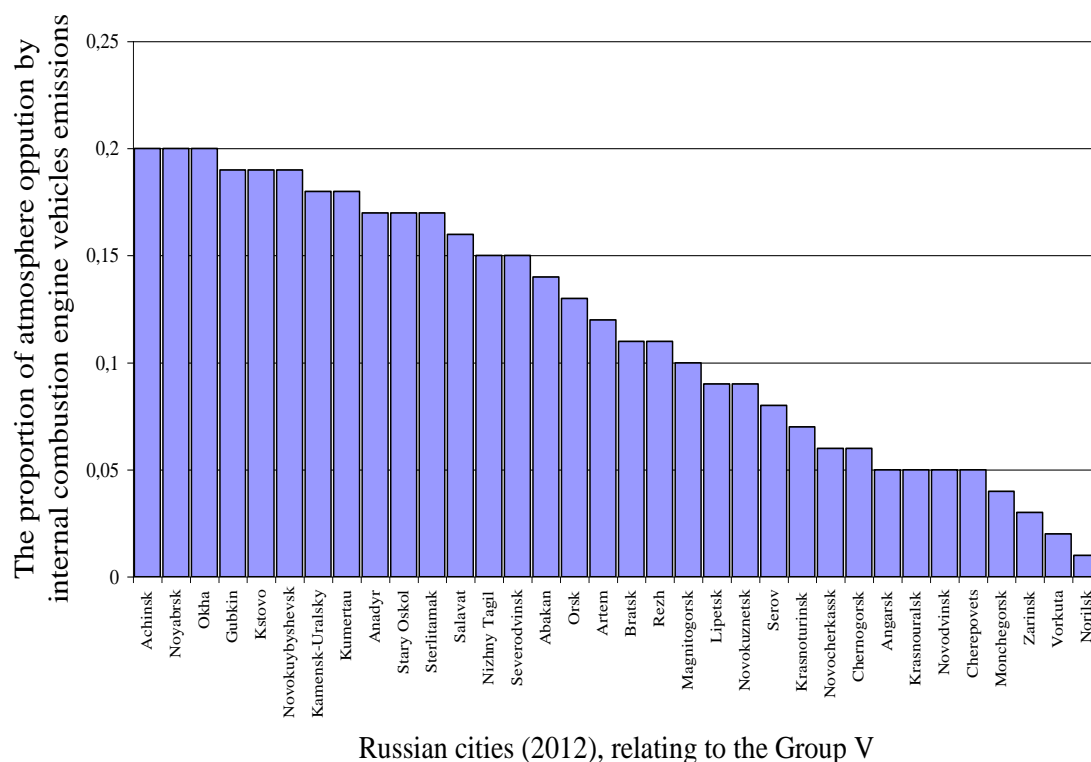


Figure 3. Russian cities (2012), relating to the Group V of classification on the basis of indicator “The proportion of atmosphere pollution by internal combustion engine vehicles emissions”

Table 4. The frequency characteristic of the classification of Russian cities on the basis of “Proportion in the total volume of pollution emissions into urban atmosphere of the internal combustion engine emissions”

Indicator	Groups of cities on the basis of “Proportion in the total volume of pollution emissions into urban atmosphere of the internal combustion engine emissions”				
	I	II	III	IV	V
Range of values	0.81...1.00	0.61...0.80	0.41...0.60	0.21...0.40	0...0.20
Quantity of cities in group	30	47	37	32	34

Cities of V group are mainly monotown of industrial specialization, in which pollution is formed in large quantities by stationary sources. Atmospheric pollution of automobile origin in such cities cannot compete with emissions from industrial manufactures.

Cities of intermediate II, III and IV groups have mixed (in different proportions) signs of cities of I and V groups. By belonging of the city to any group on the basis of “Proportion of the internal combustion engine emissions in pollution emissions into urban atmosphere” you can make basic conclusions about the specialization of city's production and the leading role of productions of certain technological paradigm in the city's economy.

4. Conclusion.

In conclusion, the following points should be noted.

1. Generally in recent years in most cities of Russia a slight improvement in air pollution can be noted.

2. Air pollution of Russian cities varies in a wide range of values (from 0.03 to 11.05 tons/person/year).
3. Russian cities can be classified according to the degree of air pollution into 5 groups. 27 of the 180 examined cities in the country refers to the most problematic fifth group.
4. In different cities of the country priority sources of air pollution are cars and stationary pollution sources.

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